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Grasshoppers and crickets (Orthoptera) and mantids (Mantodea) of sand dunes in the Danube lowland (S-Slovakia)

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A b s t r a c t : Grasshoppers and crickets (Orthoptera) and mantids (Mantodea) of sand dunes in the Danube lowland (S-Slovakia).

Blown sands and sand dunes belong to the priority habitats in Europe. Altogether 55 Orthoptera species (46 % of the species recorded in Slovakia) and one species of Mantodea were found in 11 sandy localities in the Danube lowland (S Slovakia) in 2002-2003. Comparing with results of research before 50 years, there were confirmed following pseudopsamophiles: *Docostaurus brevicollis* (frequency = 45.5%), *Myrmeleotettix antennatus* (36.4%), *Acrida hungarica* (27.3%) and *Omocestus petraeus* (27.3%), less abundant were *Platycleis affinis* (18%), *Stenobothrus fischeri* (18%) and rare *Oedalus decorus* (9.1%) and *Sphingonotus caeruleus* (9.1%). To the valuable findings there also belong hygrophilous species *Ruspolia nitidula*, *Xya pfaendleri*, *Pteronemobius heydenii*, *Conocephalus dorsalis*, *Tetrix bolivari*, from xerothermophiles *Platycleis vittata*, *Melanogryllus desertus*, *Aiolopus thalassinus*, *Euchorthippus declivus*, *E. pulvinatus*, *Stenobothrus crassipes* and *S. nigromaculatus*. The most frequent species include xerothermophilous species *Oecanthus pellucens*, *Chorthippus brunneus*, *Ch. mollis*, *Mantis religiosa* (100%), *Leptophyes albivittata*, *Phaneroptera falcata*, *Tettigonia viridissima*, *Chorthippus apricarius* and *Omocestus haemorrhoidalis* (about 92%). Comments to the distribution, abundance and biology of seven pseudopsamophilous species are also given.

Key words : Orthopterous insects, sand ecosystems, limits in distribution, zoogeography

Introduction

Blown sands and sand dunes belong to the priority habitats of European significance in the system NATURA 2000 (BERG 2002, STANOVÁ & VALACHOVIČ 2002). Up to the present time, they have provided also in Slovakia refuges for several species and groups of threatened plants and animals (KALIVODOVÁ et al. 2002). The significance of the preserved sand localities for high-specialised species of the European orthoptero fauna has been mentioned by several authors (i.e. in Germany MERKEL 1980, INGRISCH 1987, DETZEL 1998, in Hungary RÁCZ 1986, SZÖNYI & KINCSEK 1986, in Austria BERG 2002, etc). In connection with the mapping of significant biotopes of the net NATURA 2000 in the last ten years, blown sands and dunes have been subjected to more detailed examination also in Slovakia (MAJZLAN et al. 2000, GAVLAS 2002, KALIVODOVÁ et al. 2002, KRIŠTÍN et al. 2004).

Already in the past, the sands of the Danube lowland (Podunajská nížina) belonged to the most valuable localities for stenotopic orthopterous insects of former Czechoslovakia (MAŘAN 1952, 1953, 1954, ČEJCHAN 1961, 1985). These localities with identified several species having their northern distribution limit in Europe are significant refuges for the Ponto-Mediterranean fauna. In the last 50 years, many of these localities have been extinct because of intensive agriculture; on the other hand, many of them are in the stage of progressive succession owing to the opposite extreme – they have been left abandoned or they are managed with prospects for conservation. Several of them are threatened with destruction. For this reason, a thorough survey was necessary to obtain a base for their preservation or potential use also in connection with the global warming.

The goal of this work was to know the structure of the assemblages of Orthoptera and Mantodea in the most preserved sand dunes in the Danube lowland, to provide a contribution to the knowledge on the distribution and biology of pseudopsamophilous or psamophilous species and to perform analysis of changes in their distribution beginning with the early 50s of the last century. Not the lowest significance has been assigned to the proposal of recommendations for the protective management of the studied localities.

Methods and material

The research into Orthoptera and Mantodea run on 11 localities in the Danube lowland, S Slovakia (47°46'48"07'N, 17°41'18"34'E, Fig. 1). The studied localities represented the most characteristic and the most preserved of the reported blown sands and sand dunes of the Slovak part of the Danube lowland with typical psamophilous vegetation. The survey of both quality and quantity of the studied assemblages was performed regularly – once in a month from May to October 2002-2003. Beginning with 1991, the ecological data were supplemented with the results of irregularly performed observations (1994, 1996, 1999, 2000, 2001). The material was primarily collected using the method of sweeping of herbal and partially shrub vegetation (min. 1000 sweeps/check). This method was supplemented with acoustical identification, beating from trees and shrubs and individual collection of specimens. The time reserved for the active collection was two hours per plot and control. In total there were identified about 28 thousand of Orthoptera individuals.

The relative abundance of the individual species on the studied plots was expressed using the following classification scale: 1 – very rare species (less than 3 adult exemplars), 2 – rare (3-10 exemplars), 3 – abundant (11-100 exemplars), 4 – very abundant (101 and more exemplars, Table 1). Relative semiquantitative values of abundance listed in the results represent the highest recorded values in the adults corresponding to one locality and one control event (Table 1). Frequency (F%) of occurrence in every species was calculated from 11 localities.

The material was determined directly in field; only controversial and difficult to identify individuals were fixed using 75 % benzinealcohol and determined in the laboratory using identification keys (HARZ 1969, 1975). The system and the nomenclature followed the work by KOČÁREK et al. (1999), the geographical data about the origin and distribution (HARZ 1969, 1975, INGRISCH & KÖHLER 1998).

Short description of the studied plots

The eolian carbonate sands in the Danube lowland have been formed by the blowing up of course-grained particles from alluvial sediments of adjacent water flows. In total, there are about 150 km of sandy substrates, of which 140 km are blown sands on Danube lowland. At present, in total 105 km of blown sands are utilized there for the planting of agricultural crops.

The research into Orthoptera and Mantodea was conducted on 11 relatively preserved plots (partially in protected areas) at elevations 110-125 m a.s. l.:

1. Čenkovská step steppe (ČS) – National Nature Reserve, territory of the reserve with an old shooting range, locality characteristic with the stands of *Stipa capillata*, *S. joannis*, *Dianthus serotinus*, *Ephedra distachya*, *Colchicum arenaria*, cadastre territory (c.t.) Mužla, (2 ha, 110 m a.s.l.), No. of square of the Databank of Slovakian Fauna (DFS) 8277
2. Čenkovská lesostep (ČL) – National Nature Reserve, originally a forest-steppe reservation, at present with a strong secondary forest cover (*Populus alba*, *Pinus silvestris*) and invasion woody plants (*Ailanthus glandulosa*, *Robinia pseudoacacia*), with relict occurrence *Iris arenaria* and *Ephedra distachya* in the understorey, c.t. Mužla, (2 ha, 110 m a.s.l.), DFS 8277
3. Čenkov – Jurský Chlm (ČT) – depressions in the sand dunes covered with a stand of *Phragmites* sp. and hygrophilous vegetation i.e. *Carex riparia*, *Festuca arundinacea*, *Inula britannica*, *Sonchus arvensis*, about 1 km N from the former locality, c.t. Mužla, (4 ha, 108 m a.s.l.), DFS 8277
4. Mašán (MŠ) – Nature Reserve and the surrounding sand dunes with preserved psamphytic vegetation (*Gypsophila paniculata*, *Chrysopogon gryllus*, *Phleum phleoides*, *Stipa capillata*, *S. joannis*, *Verbascum phoeniceum*) and the borders of the adjacent gravel pit c.t. Radvaň nad Dunajom (ca 3 ha, 110-125 m a.s.l.), DFS 8275
5. Marcelovské piesky (MA) – Nature Reserve, territory of the reserve with considerably changed and re-ruderalised vegetation (*Bassia laniflora*, *Festuca rupicola*, *Poa bubosa*, *Xeranthemum annuum*) at the centre of the village, secondary stands of *Robinia pseudoacacia* are regularly removed, c.t. Marcelová (1 ha, 115 m a.s.l.), DFS 8275
6. Chotínske piesky (CHP) – Nature Reserve, the territory of the reserve is to a high degree ruderalised with considerably altered vegetation (*Acosta rhenana*, *Bromus tectorum*, *Conyza canadensis*, *Cynodon dactylon*, *Linaria genistifolia*). The borders are grown with stands of *Robinia pseudoacacia*, c.t. Chotín (1 ha, 110 m a.s.l.), DFS 8175
7. Chotín (CHS) – a sand dune in the territory of a former, at present abandoned state farm 1 km N from the above mentioned Nature reserve, with locally preserved psamphilous vegetation (*Bassia laniflora*, *Cynodon dactylon*, *Stipa* sp., *Tribulus terrestris*, *Verbascum* sp.) and ruins of farmhouses, c.t. Chotín (2 ha, 115 m a.s.l.), DFS 8175
8. Abov Sesileš (AB) – extensive sand dunes and denudations (300 × 80-100 m) with a mosaic of various herbal (*Bromus tectorum*, *Corispermum nitidum*, *Gypsophila paniculata*, *Trifolium arvense*, *Verbascum densiflorum*, *Xeranthemum annuum*)

and shrub (*Salix* sp.) vegetation, which is locally turning to ruderal type, c.t. Martovce (3 ha, 110-120 m a.s.l.), DFS 8174

9. Lišcie Diery (LIS) – sandy dunes with preserved psamphytic vegetation (*Stipa capillata*, *S. joannis*, *Gypsophila paniculata*, *Syrenia cana*, *Dianthus serotinus*, *Polygonum arenarium*), in contact with an open stand of *Robinia pseudoacacia*, in proximity of intensively managed agricultural land and forest, c.t. Nesvady (2 ha, 115-120 m a.s.l.), DFS 8074
10. Tomášikovský presyp dune (TP) – a remnant of a sand dune with strongly re-ruderalised vegetation (*Carex stenophylla*, *Erysimum diffusum*, *Festuca rupicola*, *Gypsophila paniculata*, *Silene otites*, *Stipa pulcherrima*), isolated from the original biotopes in the agricultural land, c.t. Tomášikovo (0.5 ha, 115-120 m a.s.l.), DFS 7972
11. Mostovské presypy dunes (MP) – ruderalised remnants of three sand dunes with (*Anchusa officinalis*, *Arrhenatherum elatius*, *Festuca rupicola*, *Gypsophila paniculata*, *Poa bulbosa*) isolated in an intensively managed field, c.t. Mostová, Vozokany (0.5 ha, 115-120 m a.s.l.), DFS 7872

Results and discussion

Assemblage structure

In the reported 11 localities, there were found in 2002-2003 altogether 55 (46 % of the species recorded in Slovakia) mostly thermophilous Orthoptera species and one species of Mantodea (Tab. 1). This number included six species listed in the National Red List (KRIŠTÍN 2001). Characteristic and precious are mainly so called pseudopsamophilous species (Mařan 1954), in Slovakia identified only in warm loose sands in spite of the fact that in the Mediterranean area and other regions of Southern Europe they also occur on other substrates and soils. From these pseudopsamophiles the most frequent were the species *Dociostaurus brevicollis* (frequency = 45.5%), *Myrmeleotettix antennatus* (36.4%), *Acrida hungarica* (27.3%) and *Omocestus petraeus* (27.3%), less abundant were *Platycleis affinis* (18%), *Stenobothrus fischeri* (18%) and rare *Oedalus decorus* (9.1%) and *Sphingonotus caeruleus* (9.1%). These species (except *Sphingonotus caeruleus*) were rarely identified also 50 years ago by MAŘAN (1954) examining sand localities in Southern Slovakia, and up to present they can be considered as indicators of the preserved sand dunes in the Danube lowland. To more rare findings there also belong hygrophilous species *Ruspolia nitidula* (in the National Red List as EN – endangered), *Xya pfaendleri* (LR), *Pteronemobius heydenii*, *Conocephalus dorsalis*, *Tetrix bolivari*, from xerothermophiles also *Platycleis vittata*, *Melanogryllus desertus*, *Aiolopus thalassinus*, *Euchorthippus declivus*, *E. pulvinatus*, *Stenobothrus crassipes* and *S. nigromaculatus* (Table 1).

The most frequent species of Orthoptera in the studied localities include xerothermophilous species *Oecanthus pellucens*, *Chorthippus brunneus*, *Ch. mollis* (100% of the localities – always with the simultaneous occurrence of *Mantis religiosa*), followed by *Leptophyes albovittata*, *Phaneroptera falcata*, *Tettigonia viridissima*, *Chorthippus*

apricarius and *Omocestus haemorrhoidalis* (about 92%). To the most abundant species – with abundance varying in dependence on the locality, year and season belonged *Oecanthus pellucens*, *Leptophyes albobittata*, *Oedipoda caerulea*, *Dociostaurus brevicollis*, *Euchorthippus pulvinatus* and in wet sand depressions covered with reed also *Conocephalus discolor* and *Xya pfaendleri*.

In the separate localities were found from eight to 34 Orthoptera species, mantids occurred in all the localities. The abundance of the species in the individual localities correlated with the diversity of the local vegetation, microhabitat mosaic pattern and the degree of preservation or the isolation of the locality. The lowest species richness was found in sand dunes, isolated from the preserved biotopes with intensively managed fields, where only euryvalent species have chance for survival (eight Orthoptera species in the locality Mostovské presypy and by 18 species in two other localities, Table 1). Poor in the species richness (17 species) was also the locality Čenkovská lesostep forest-steppe, negatively influenced by a secondary forest succession. The transformation of the forest-steppe to forest was also indicated by several species fixed to woody plants or forest understorey (*Pholidoptera griseoptera*, *Meconema thalassinum*, *Chorthippus vagans*). On the other hand, in relatively preserved localities, there occurred in average by 25 species. The highest number of species – 34 was identified in the locality enriched with a depression with reed on sandy banks complemented, in addition to common typical xerothermophilous species on dunes, with typically hygrophilous species as *Ruspolia nitidula*, *Pteronemobius heydeni*, *Tetrix bolivari* and *Xya pfaendleri* (locality Mašan, Table 1).

We suppose that the 55 identified Orthoptera species do not represent the final figure for the species living in the sandy localities of the Danube lowland. In the surrounding biotopes we have also found additional species (*Pezotettix giornae*, *Gomphocerippus rufus*, *Mecostethus parapleurus*, KRIŠTÍN et al. in press). It is probable that these and also other species (e.g. *Platycleis montana*, identified in the sands of the Borská nížina – GAVLAS 2002, and of Eastern Slovakia – KRIŠTÍN et al. 2004) together with several species non-reported from the past can still be identified at a more detailed study also in the blown sands in the Danube lowland and that the total number of the identified species can exceed 60.

Comments to the occurrence and biology of some pseudosamophilous species

Comparing the contemporary structure of the Orthoptera assemblages in the sand dunes in the Danube lowland with situation at the site 50 (MAŠAN 1954), or 40 years ago (ČEJCHAN 1961, 1985), we have not confirmed the former occurrence in the case of four species. In none of the studied localities there have been confirmed the species *Calliptamus barbarus* and *Celes variabilis* found in 1952-1953 by Mašan (1954) in the sands of the Čenkovská step Nature Reserve, *Acrotylus insubricus* identified in 1960 in the Nature Reserves (NNR) Čenkovská step and Chotínske piesky by ČEJCHAN (1961). We have neither confirmed the species *Platycleis montana*, identified rarely in 1960 and 1962 in the NR Čenkovská step by ČEJCHAN (1985). This species is a characteristic species of the sands in the Záhorie region and in the Východoslovenská nížina lowland (GAVLAS 2002, KRIŠTÍN et al. in press).

Acrida ungarica (in the National Red List classified as VU – vulnerable) is also evidently receding from the commonly known sandy localities in Slovakia. In 2002-2003, we recorded this species only in three mutually independent localities in the Danube lowland (Table 1). In two other studied localities (NNR Čenkovská lesostep and NNR Chotínske piesky), the species was registered in 1991-1994; however, in 1999-2003 even one single exemplar was not found. This species was absent also in the locality Marcelová, where a rare occurrence was still reported in 1990 by ŠUŠLÍK (1996). The species has also been extinct from the sandy areas in Eastern Slovakia where abundant occurrence was registered in several localities in the 50s of the last century (MAŘAN 1954) and again in 1961-1962 by GULIČKA (1992 and the collections of Slovak National Museum in Bratislava). In our surveys performed in 1997-2003 on 14 sandy localities, no occurrence of this species was registered (KRIŠTÍN et al. 2004). No occurrence has been detected in the sands of the Borská nížina lowland (GAVLAS 2002), and, in such a way, the species reach at present in the Danube lowland its north-western occurrence limit in Europe. In the three studied localities we found an abundance of 20-30 adults/ha (e.g. Chotín farm – 26 males (♂), 4 females (F), 4 nymphs, July 21, 2003, Abov – 22 ♂♂, 3 ♀♀, 5 nymphs, Líšcie diery 21 ♂♂, 3 ♀♀, 4 nymphs). The imagoes were registered from July 10 to October 15. They prefer plots with herbal vegetation (*Stipa* sp., *Gypsophila* sp.) occurring there both on tops of the dunes and in depressions. From the neighbouring countries, a regular distribution exists only in the South of Hungary (RÁCZ 1986, NAGY 1991, 1996, NAGY & SZÖVENYI 2001). In Austria, the last record on this species has been dated from the end of the 60s of the last century (BERG & ZUNA-KRATKY 1997). In the Czech Republic, the last record was obtained in 1875 near Brno (OBENBERGER 1926) and from Poland no registration is known (BAZYLUK 1956).

The pseudopsamophilous, mediterranean species *Platycleis affinis* (in Slovakia it also reaches its northern occurrence limit in C Europe) we only registered in two localities in the Danube lowland. It is similar to the situation 50 or 40 years ago, when it was found by MAŘAN (1954) and ČEJCHAN (1961). The highest abundance we found in the locality Chotín farm (about 2 km N from the NR Chotínske piesky, where it was registered by MAŘAN and ČEJCHAN (l.c.) and where no present occurrence could be detected). We found there max. 6 ♂♂ and 14 ♀♀/ha (July 21, 2003). Rare was this species in the NR Čenkovská step (1 ♀, August 1, 2002). In opposite to *A. ungarica*, this species prefers denuded sandy plots with scarce grassy vegetation in depressions between the dunes. In Austria, the species is endangered to extinction and registered mainly in the East of the land (BERG & ZUNA-KRATKY 1997). In Hungary, it is regularly registered in suitable habitats, e.g. in the NP Hortobágy and NR Bátorliget (NAGY 1983, 1991). In the Czech Republic and in Poland the species has not been found.

The species *Myrmeleotettix antennatus*, of Angaro-Pontic origin is another rare pseudopsamophile, registered, however, relatively frequently (36.4 %). The species is fixed to preserved sandy plots with scarce herbal vegetation (and species *Stipa* sp., *Gypsophila* sp., *Dianthus serotinus*, *Verbascum phoeniceum*, the highest abundance was observed in locality Líšcie diery (3 ♂♂, 4 ♀♀, August 1, 2002) and the NNR Čenkovská step (2 ♂♂, 2 ♀♀, July 21, 2003), a rare one on the sandy dunes of Mašan and Abov (by 1 ♂, August 1, 2002). In the Danube lowland no simultaneous occurrence with the congeneric species *M. maculatus*, was found in the studied localities. On the other hand, in four localities studied in the East Slovakian lowland both species occurred also simultaneously (KRIŠTÍN et al. 2004). Adults were registered from the beginning of July to the beginning of Octo-

ber. In Austria, the species has practically been extinct (BERG 2002), from Hungary we have a mention by e.g. NAGY (1958) and RÁCZ (1986). No occurrence has been documented either in the Czech Republic or in Poland; consequently, the species reaches in Slovakia the northern limit of its occurrence in Central Europe.

The stenovalent psamphilous species of Pontic origin *Stenobothrus fischeri* was only rarely identified in two adjacent localities the NNR Čenkovská step and NNR Čenkovská lesostep. We found the species the most abundant in scarce herbal stands (*Stipa* sp., *Ephedra distachya*, *Dianthus serotinus*) in June (21.6.2000, 19♂♂, 16♀♀), less in July (21.7. 2003 – 4♀♀, 1♂), and in September it was not found any more. It is possible that it escapes from the consideration accurately thanks to its early occurrence (cf. Berg 2002). Similar to Hungary, also in the NNR Čenkovská step the species was found in co-occurrence with other pseudopsamophiles *M. antennatus*, *P. affinis*, *O. decorus* (i.e. NAGY 1958, RÁCZ 1986). In Austria it was considered extinct up to 1997 (BERG & ZUNA-KRATKY 1997), however, in 1999 it was found again in stands of *Stipa* sp. in the Reserve Oberweiden in NE Austria. Currently, it is the record confirming the North-westernmost occurrence in Central Europe, because the species has not been found either in the Czech Republic or in Poland.

The Mediterranean species *Oedalus decorus* (Fig. 2) was still 40-50 years ago abundantly registered in the sands of Chotínske piesky NR (MAŘAN 1954, ČEJCHAN 1961). It seems that today it is very rare because within our study running in 1991-2003 we registered in the whole Slovakia only one finding of a female in the NNR Čenkovská step (July 21, 2003), in co-occurrence with a very abundant population of *Euchorthippus pulvinatus*. This species has also been extinct from the sands in Eastern Slovakia where it was abundantly registered in blown sands in the 50s of the last century (MAŘAN 1954) and observed still in 1961-1962 by GULIČKA (1992, in the collections of Slovak National Museum in Bratislava). It also has been extinct in Austria (BERG & ZUNA-KRATKY 1997, BERG 2002), up to the present time are known registrations from Hungary to the south of the Balaton lake (NAGY & SZÖVÉNYI 2001) and exceptionally also from Northern Hungary (near Miskolc, NAGY 1996), some older data come from the NP Hortobágy (NAGY 1983) and NR Bátorliget (NAGY 1991). In the Czech Republic is the species considered extinct (KOČÁREK et al 1999), in Poland it has not been registered. Consequently, in Slovakia it reaches the northern documented limit of its occurrence range in Europe.

The species *Sphingonotus caeruleus* of Angaric origin is one of few European species, which are considered genuine psamophiles and are pioneers in occupation of intact, incompact and denudated sand dunes and gravel pits (INGRISCH & KÖHLER 1998). In spite of the fact that this species is up to present common on denudated sands and gravel pits over the entire Europe (DETZEL 1998), we observed it only in one locality from all our study plots - an extensive sand pit in the locality Abov. The local population at the site reached a maximum number of adults 46♀♀ and 41♂♂ /2 ha (July 21, 2003), the occurrence of imago was registered from July to October. In contrast to the other pseudopsamophiles, this species prefers totally denudated sandy plots without vegetation. Together with this species there were also abundant pseudopsamophiles *Dociostaurus bervicollis*, *Acrida ungarica*, less abundant was *Myrmeleotettix antennatus*, and xerothermophiles *Platycleis vittata*, *Stenobothrus crassipes*. From 1960 exists a mention about the occurrence in the locality Čenkovská step by ČEJCHAN (1961); MAŘAN (1954) did not mention it in connection with his surveys running in 1952-1953,

and neither we registered it there over 1991-2003. In the Slovakia, this species has rarely been found in the Záhorie region (W Slovakia, CHLÁDEK & HOLUŠA 1992). It also rarely occurs in Austria (BERG 2002), the Czech Republic (CHLÁDEK & HOLUŠA 1992). In Poland, it is a common species (BAZYLUK 1956).

The Ponto-Mediterranean species *Dociostaurus brevicollis* has been found up to present the most frequent ($F = 45\%$) and the most abundant pseudopsamophile in the Danube lowland (Table 1). The species reached its highest abundance in the territory of Chotín (locality public farm); representing more than 100 adults /ha, at the same time it occurred there also in intensively managed maize fields. The species also regularly occurs in other sandy and ruderal localities of Southern and Eastern Slovakia (GAVLAS 2002 – Záhorie, KRIŠTÍN & SÁROSSY 2002, KRIŠTÍN et al. 2004). We registered adults from the end of June to October. In Hungary is the species common in favourable localities (RÁCZ 1986, NAGY 1996), from the Czech Republic it has only been reported occurring in the SE part of the country (KOČÁREK et al. 1999), in Austria is endangered to extinction (BERG 2002), and from Poland no records are known (BAZYLUK 1956).

Recommendations for the protective management of the sands in the Danube lowland based on the research into Orthoptera and Mantodea

Based on the negative phenomena observed in the sandy localities in the Danube lowland we propose to subject the discussed area to the following protective measures:

1. the sandy localities are to be subjected to regular cleaning performed at three year intervals, by removing black locust and other alien woody plants (*Robinia*, *Ailanthus*, mainly in the NNR Čenkovská step)
2. on the blown sands covered with dense ruderal and alien herbal vegetation (mainly the NNR Chotínske piesky, NR Mašan), sandy walls with denudated sandy areas (10 m in width, 2 m in height) are to be created in such a way that the sand will be raked off to the wall foot with an area of about 10×10 m. Such nude plot is necessary for the larval development and ensuring the occurrence of several pseudopsamophilous Orthoptera species
3. intervention into the bank areas of water depressions is to be avoided (because of the protection of hygropsamophilous species *Xya*, *Pteronemobius*, *Tetrix bolivari*).
4. the plots endangered by construction and intensive agricultural activities are to be provided with protective regimens or are to be declared protected areas (localities Chotín – former state farm and Abov)

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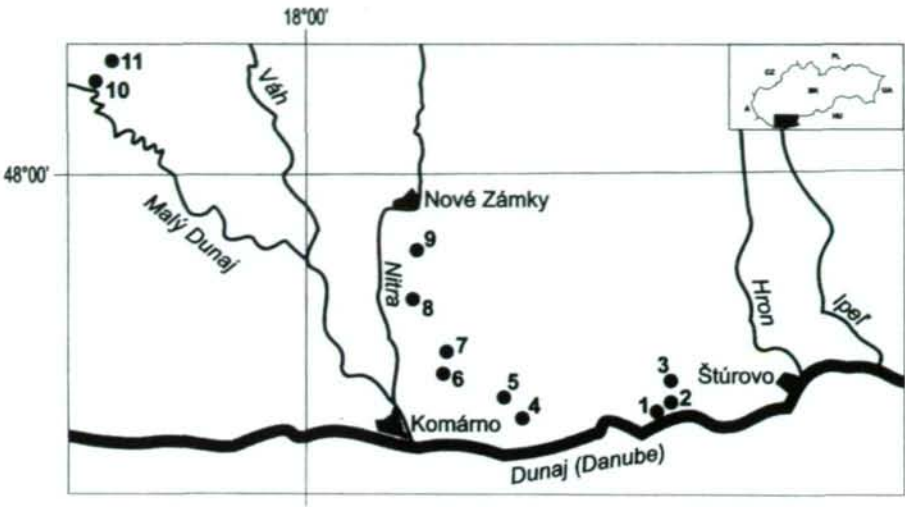


Fig. 1. Sketch of the studied 11 sandy localities in the Danube lowland with localisation within Slovakia (Localities No. 1-11, see chapter Methods).



Fig. 2: *Oedaleus decorus decorus* (GERMAR 1826).

Table 1: Grasshoppers and crickets (Orthoptera) and mantids (Mantodea) of sand dunes in the Danube lowland (S-Slovakia) (localities: see chapter Methods and Fig. 1, abundance: 1 very rare - less than 3 individuals, 2 rare - 3-10 ind., 3 abundant- 11-100 ind., 4 very abundant - more than 100 ind., F% - frequency, bold – pseudopsamophilous and psamophilous species)

<u>Species / Locality</u>	ČS	ČL	ČT	MŠ	MA	CH P	CH S	AB	LIS	TP	MP	F%
No. of locality	1	2	3	4	5	6	7	8	9	10	11	F%
ORTHOPTERA												
Ensifera												
Tettigoniodea												
<i>Leptophyes albobittata</i> (KOLLAR 1833)	3	2	3	2	2	3	3	4	3	2		91,7
<i>Phaneroptera falcata</i> (PODA 1761)	2	3	2	2	2	2	2	2	2	2		91,7
<i>Meconema thalassinum</i> (DEGEER 1773)		2							1			27,3
<i>Conocephalus fuscus</i> (FABRICIUS 1793)			4	2				1				27,3
<i>Conocephalus dorsalis dorsalis</i> (LATREILLE 1804)			2									9,1
<i>Ruspolia nitidula</i> (SCOPOLI 1786)				3	2							18,2
<i>Decticus verrucivorus</i> (LINNAEUS 1958)									3			9,1
<i>Metrioptera bicolor</i> (PHILIPPI 1830)	3		2	3	1	2	2	1	2			72,7
<i>Metrioptera roeselii roeselii</i> (HAGENBACH 1822)	3		3	3	2	1	2	1	2			72,7
<i>Pholidoptera griseoaptera</i> (DEGEER 1773)		3			1				2			27,3
<i>Platycleis albopunctata grisea</i> (FABRICIUS 1781)	2			3	3	1	2	2	3	2	1	81,8
<i>Platycleis affinis</i> FIEBER 1853	1						3					18,2
<i>Platycleis vittata</i> (CHARPENTIER 1825)							3	2				18,2
<i>Tettigonia viridissima</i> LINNAEUS 1758	2	2	2	2	2	2	1	1	2	1		91,7
<i>Ephippiger ephippiger vitium</i> (SERVILLE 1831)								1				9,1
Grylloidea												
<i>Grylotalpa grylotalpa</i> (LINNAEUS 1758)				1	1							18,2
<i>Pteronemobius heydenii</i> (FISCHER 1853)				3								9,1
<i>Gryllus campestris</i> LINNAEUS 1758	3			3	3	3	2	3	3	2	3	81,8
<i>Melanogryllus desertus</i> (PALLAS 1771)	2			2	1							27,3
<i>Modicogryllus frontalis</i> (FIEBER 1844)				2						1		9,1
<i>Oecanthus pellucens pellucens</i> (SCOPOLI 1763)	4	2	4	4	3	2	4	4	4	2	1	100
Caelifera												
<i>Xya pfaendleri pfaendleri</i> (HARZ 1970)				4								9,1
<i>Tetrix bipunctata</i> (LINNAEUS 1758)				2	1							18,2
<i>Tetrix bolivari</i> SAULCY 1901			2	3								18,2

Species / Locality	ČS	ČL	ČT	MŠ	MA	CH P	CH S	AB	LIS	TP	MP	F%	
	No. of locality	1	2	3	4	5	6	7	8	9	10		11
<i>Tetrix subulata</i> (LINNAEUS 1758)				2	2								18,2
<i>Tetrix undulata</i> (SOWERBY 1806)										1			9,1
<i>Tetrix tenuicornis</i> SAHLBERG 1893					2								9,1
<i>Calliptamus italicus</i> (LINNAEUS 1758)		3			3	3	1	2	2	2			63,6
<i>Acrida ungarica ungarica</i> (HERBST 1786)								3	3	3			27,3
<i>Aiolopus thalassinus thalassinus</i> (FABRICIUS 1781)			1										9,1
<i>Oedaleus decorus decorus</i> (GERMAR 1826)		1											9,1
<i>Oedipoda caerulescens</i> (LINNAEUS 1758)		4	3		2	3		3	3	2	2	1	81,8
<i>Sphingonotus caeruleans</i> (LINNAEUS 1767)									3				9,1
<i>Doclostaurus brevicollis</i> (EVERSMANN 1848)		2					2	4	3	3			45,5
<i>Euchorthippus declivus</i> (BRISOUT de BARNEVILLE 1849)		2			1								18,2
<i>Euchorthippus pulvinatus</i> (F. de WALDHEIM 1846)		4			4	3	3	3	2	4	2		72,7
<i>Euthistira brachyptera brachyptera</i> (OCSKAY 1826)					2								9,1
<i>Chorthippus albomarginatus</i> (DEGEER 1773)				2		1		2	2		3		45,5
<i>Chorthippus apricarius</i> (LINNAEUS 1758)		2	1	3	1	2	1	2	2	2	3		91,7
<i>Chorthippus biguttulus</i> (LINNAEUS 1758)		2	1		1	2	2		2	2	2	2	81,8
<i>Chorthippus brunneus brunneus</i> (THUNBERG 1815)		1	2	2	3	3	2	2	3	2	2	1	100
<i>Chorthippus dorsatus dorsatus</i> (ZETTERSTEDT 1821)				2		1				1	1		36,4
<i>Chorthippus mollis mollis</i> (CHARPENTIER 1825)		2	3	2	2	2	1	1	2	2	3	3	100
<i>Chorthippus parallelus</i> (ZETTERSTEDT 1821)			2	3	1		1						36,4
<i>Chorthippus vagans</i> (EVERSMANN 1848)			2										9,1
<i>Chrysochraon dispar dispar</i> (GERMAR 1834)				3	3								18,2
<i>Myrmeleotettix antennatus</i> (FIEBER 1853)		2			1				1	2			36,4
<i>Myrmeleotettix m. maculatus</i> (THUNBERG 1815)						2							9,1
<i>Omocestus haemorrhoidalis</i> (CHARPENTIER 1825)		2	1		3	2	2	2	2	3	3	3	91,7
<i>Omocestus rufipes</i> (ZETTERSTEDT 1821)							1						9,1
<i>Omocestus petraeus</i> (BRISOUT de BARNEVILLE 1856)		1					1	1					27,3
<i>Stenobothrus crassipes</i> (CHARPENTIER 1825)		1			1		2	3	1	1	1		63,6
<i>Stenobothrus fischeri</i> (EVERSMANN 1848)		3	1										18,2
<i>Stenobothrus lineatus</i> (PANZER 1796)		1	1	2	1		1	2	2	2	1		81,8
<i>Stenobothrus nigromaculatus</i> (HERRICH-SCHÄFFER 1840)		2										9,1	
Number of species (55 species)	26	17	18	34	24	21	23	26	26	18	8		
MANTODEA													
<i>Mantis religiosa</i> (LINNAEUS 1758)	3	2	2	3	1	1	2	2	3	1	1	1	100